Gamma-ray burst classification

A threshold for the completion of the exercise is to complete points 1a), 2), 3) and 4).
Gamma-ray bursts (GRBs) are usually classified into two different categories, according to their duration: short GRBs and long GRBs. The distribution of the burst duration, T , is usually modelled as the weighted sum of two log-normal distributions:

$$p(T_{90}) = w_1 \mathcal{N}(\log(T_{90}) \,|\, \mu_1, \sigma_1) + (1 - w_1)\mathcal{N}(\log(T_{90}) \,|\, \mu_2, \sigma_2)$$

We will make use of Fermi/GBM data available here (LINK). Unless stated, we will neglect measurement uncertainties.

1. Determine:
    a. The parameters of the distribution.
    b. As above, assuming Gaussian uncertainties on each $\log T_{90}$

Assuming the parameters inferred in the previous point, we now turn our attention to the problem of classifying each GRB.

2. Compute the probability of GRB170817A (T = 2.0 s) of being a short GRB or a long GRB.

3. Decide a figure of merit and determine the threshold value for T_{90} to discriminate between short and long GRBs.

Some authors propose a third class of GRBs, *intermediate*.

4. Which of the two hypothesis is favored according to the available data?

Another possibility is to classify GRBs in *soft* and *hard*, according to the hardness ratio

$$HR = F_{50-100\,kev}/F_{20-50\,kev}$$

where F is the measured flux in a certain energy interval.

5. Study the bimodal distribution in the $\log(T_{90}) - \log(HR)$ space. (Suggestion: specialize https://dp.tdhopper.com/collapsed-gibbs/ to a fixed number of components.)